The Basalt-a Material Used in Machine Tools Parts Manufacturing

The Behaviour of Basalt Parts Submitted to Thermic Stresses

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Abstract

This paper presents the results of some experimental tests concerning the basalt parts submitted to specific thermic stresses, and resulted from the operation of machine tools. The tests were also involved in similar cast iron parts, in order to compare the results and to establish the possibility of using basalt in building mechine tools.

Keywords

Materials; Measuring; Experimental Techniques; Machine Tools

Introduction

Nowadays, there is worldwide tendency to find an alternative of resource to the traditional one. The study concerning the use of basalt, an economical and widespread accessible material in building machine tools and texile machinery is doubtless an interesting challenge because these industrial branches have completely different particularities compared with chemistry or construction in which basalt has been already largely used.

Technologically, basalt holds the following advantages:

- the present casting process permits to obtain relatively big parts with different shapes and good precision;
- basalt casting does not require special conditions and can be performed on existing installations with low processing costs.

To achieve this goal, a thorough knowledge with regard to the thermic behaviour of basalt parts is needed, mainly the temperature field and the resulting deformations (Predincea, 1990).

Bibliographical studies show that the basalt has not been studied so far as material for machine tools building, so that this research includes the authors's own contribution on the study of the thermic behaviour of basalt parts submitted to thermic stresses.

The work is structured in the following directions: illustration of the problem, presentation of the test conditions and methodology, of methods, of experimental results and their interpretation, conclusions and recommendations regarding implementation fields.

The factorial quantitative type has been employedin the experiment carried out on the aspects of the experimental plan and guildance as well as the collection and statistical process of data. (Ispas et al., 1992).

PROBLEM Statements

During operation, he machine tool is submitted to various factors determining the predominant forms of stress as follows:

- the net wight of fixed and mobile assemblies, of the workpiece and rigs - acting as a static working load;
- the cutting forces and the parts in motion - acting as a dynamic load;
- frictional losses; the heat generated from the cutting process determines thermic deformations (Ispas et al., 1993).

Thus, the structural elements of machine tools are stressed in different ways when taking into consideration the format factors.

As a material for body and housing parts of machine tools, basalt has not been studied yet, but it can be accepted as a possible replacement solution.

Technologically, a main size of 800 mm seems to be the upper limit for basalt parts. A complex machine structure (like housing, body, trunk, lug support, base) is composed of joint basic parts (rungs, plates) (Gornic et al., 1989).

Testing Methodology

According to the analyzed output parameters, it was drafted by three experimental test programs, each of which has the same experimental development including; testing methodology, the use of specific measuring apparatus, experimental test data records, data processing and resulting conclusions. In the course of the test performation all the disturbing factors which affect the measuring results were considered.

The test was performed using two types of cast basalt plates as well as a gray iron plate (Fc 250) of similar size for the comparison of the results.

During the test, both plates (basalt and gray cast iron) have been warmed up in order to simulate real operation conditions. The heating was carried out by using an electric resistor powered by an adjustable voltage source. Planing the resistor inside a box (as shown in FIG. 1) the whole amount of the generated beat is transferred to the plate surface (Popp, 1999).

Test conditions:

- plates made of cast and recristallized basalt using the following heating rates: amount of heat Q_{11} = 210 Kcal/h (150 W) and Q_{12} = 390 Kcal/h (280 W);
- plates made of gray cast iron warmed up by the heating source Q_{31} = 390 Kcal/h

The temperature values in the measurement points were measured using an ELR 12 channels temperature recorder, a Termophil type contact thermometer and a Hg thermometer, all of them fixed on the plate during the test. Ultrakust brand Fe-Const thermocouple elements were used as temperature transducer.

Data were recorded for the following measured parameters:

- inside box temperature;
- surrounding temperature;
- selected points temperature T1- T6 (FIG. 2);
- relative shiftings measured on the co-ordinates of the selected points C_1 - C_6 (FIG. 2).

Parameters variation was measured with an period)t_1 = 15 min increment during the first test hour and period)t_2 = 30 min up to thermic stability.

Results Interpretation

The behaviour of melted and recrystallized basalt has been studied as a possible material for machine parts.

Based on the experimental findings the following graphs were drawn:

- the graph of temperatures measured during the plates heating (as shown in FIG. 3);
- the graph of relative process shiftings recorded in the measurement points (FIG. 4).

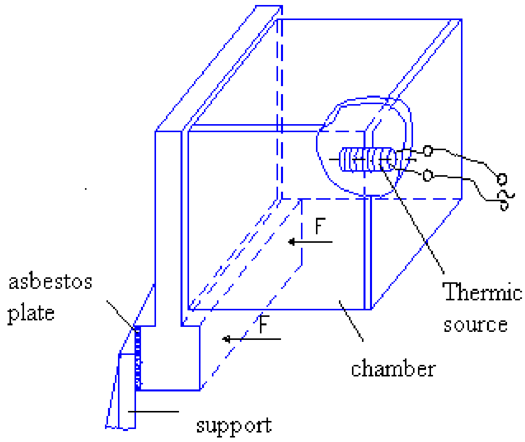

FIG. 1 SCHEME OF EXPERIMENTAL PLANT

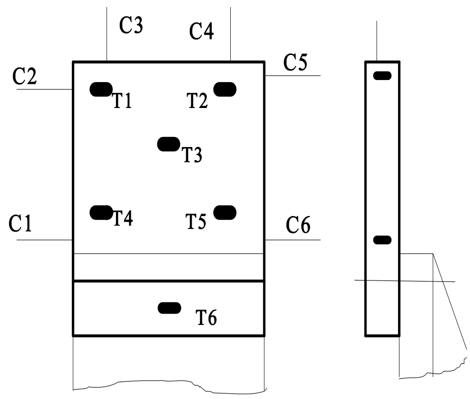

FIG. 2 MEASUREMENT POINTS OF TEMPERATURES AND SHIFTINGS

Conclusions

This experimental research leads to the following conclusions:

The thermic stabilization time of the cast iron model is lower than the similar time for basalt four and five hours, respectively

- the thermo-convection factor of basalt being by 40% lower than that of gray cast iron.

- The conduction heat transfer coefficient of basalt is also lower than that of gray cast iron. Therefore elements of basalt should be as thin as possible in order to achieve an optimal thermic behaviour.

For the same length the linear dilatation coefficient of basalt is by ca. 22% lower than thant of cast iron.

- For heat conduction reasons, the thermic behaviour of basalt may be improved by heat exchangers placed on the hottest surfaces.

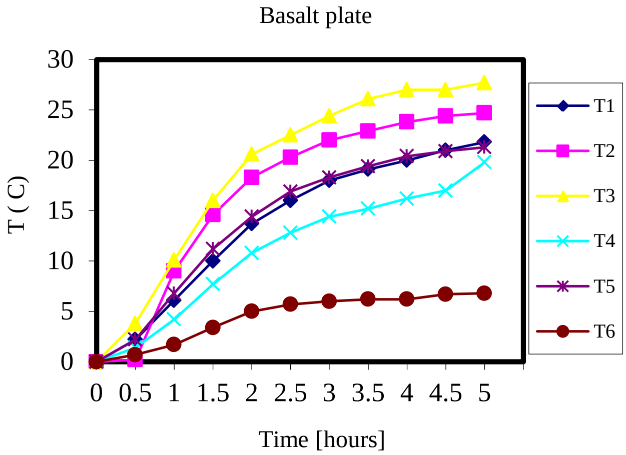

FIG. 2 GRAPH OF TEMPERATURES

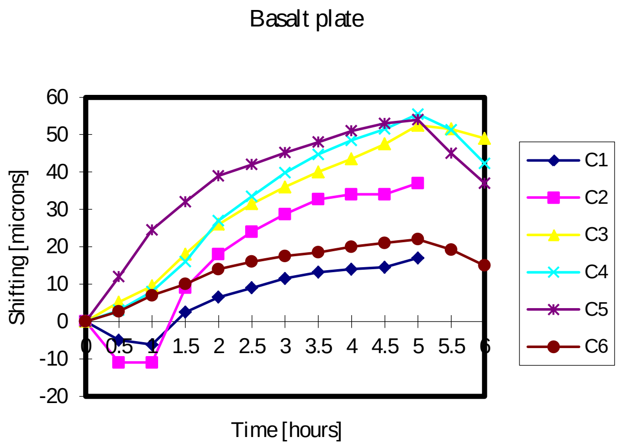

FIG. 3 GRAPH OF SHIFTINGS

- For making the heat exchange more effective, a pump should be used for cooling the heated basalt surfaces.
- Having a low thermic deformation factor machine tools, bodies of basalt enable a high machining accuracy.

According to experimental tests, there are following conclusions and recommendations regarding basalt using as a body material for machine tools building:

- The building of the main machine-tools parts (bodies, transit paths, supporting tables, rest slides) may be in combination with traditional metallic materials which must correct some drawbacks of this material the depressed toughness and the small plasticity in order to obtain lighter and cheaper machine tools structures, with a good static, thermic and dynamic behaviour.
- In the building of finishing machines (circular grinder, face grinder, universal grinding machines, boring machine, honing machines) characterized with small cutting forces, high sensitive and dynamic stability should be obtained by sturdy structures, expensive metallic materials, special steels, gray cast iron with graphite nodules.

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Ilie Octavian Popp was born in 1961, Sibiu, Romania. He majored in Machine Building Technology and graduated from Technical University of Cluj-Napoca, 1986; afterward, he achieved his Ph.D from University of Sibiu in 1999 with the doctoral dissertation titled *Contributions to research the behavior of basalt submitted to specific strain of machine tools.*

He has worked as engineer in Techical Department (Production Military) and design Engineer (product and technology, SDV devices,) Mechanical Plant MIRSA Avrig, Sibiu County. Since 1992, he has committed in the Faculty of Engineering, University of Sibiu as accosiate profession. So far, he has published more than seventy scientific papers and nine research grants as a team member; meantime, he is also the co-author of seven books. Currently, his research interests are Machining Technologies Numerically controlled machine tools; Machinery and equipments maintenance; Flexible manufacturing systems.

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